Detection of Amino Acids/Organics on an Open-Tubular Ion/Liquid Chromatograph

Completed Technology Project (2015 - 2018)

Project Introduction

Science Goals and Objectives We propose to develop a open tubular (OT) ion/liquid chromatograph (I/LC) with pulsed amperometry and UV array detection for identification and chiral separation of amino acids. This is a follow-up to the already established capabilities of OTIC to characterize soluble inorganic and small organic ions (formate, acetate, benzoate etc.). The final deliverable will be a TRL4 instrument that can both help characterize the habitability of an environment by measuring inorganic and organic ions as well as searching for a specific biomarker, namely amino acids and specifically their chirality. By combining chiral measurements of amino acids with a broader survey of the inorganic and organic constituents, our compact instrument will provide multiple pieces of evidence about the possibility of past or present life on other planetary bodies. Methodology Separation of amino acids on multifunctional ion exchange media in macroscale columns with ionic eluents and pulsed amperometric detection is already an established commercial technique. Open tubular columns of same functionality have not been developed, but should not pose a major hurdle. Our present OT column fabrication process allows us to also readily make reverse phase columns, better suited for looking for nonionic organics. The first goal of this work will be to develop and demonstrate OT separations of amino acids. We will then extend the standard amino acid separation to chiral separations using a chiral stationary phase and/or a chiral eluent. A pulsed amperometric detector will be demonstrated for amino acid identification with high sensitivity. The availability of LEDs down to the deep UV and active pixel array imaging technology now enable sensitive capillary scale UV detection, this will be used for the detection of nonionic organics. Through previous ASTID funding (PI Dasgupta), we have made fundamental advances in fabricating polymethylmethacrylate OT capillary columns that can be dried, frozen and thawed repeatedly without any adverse effect on performance. We have also developed a portable OTIC instrument that works with pL-nL scale samples reproducibly, can accomplish a common 5 anion separation in less than 2 min, consumes <1 W of power and weighs < 2 kg in present form. This instrument will be the platform for integrating the novel OT columns for amino acid separation as well as the novel UV absorbance detector array. Relevance Understanding the habitability of other places in our solar system and searching for evidence of past or present life is a key goal of NASA's space Exploration Program. These goals are also directly identified in the 'Planetary habitats' crosscutting theme of the 2013-22 planetary science decadal survey. This instrument will enable a deeper understanding of habitability and potentially life, and is well suited for incorporation in the proposed Discovery class Icebreaker mission. Icebreaker seeks to search for biomolecular signs of life below the surface at Martian poles as well as characterize past and present habitability of its landing site. This proposal will expand the capabilities of the current OTIC system to allow amino acid biomarker detection, taking this capability from TRL2 - TRL4, by incorporating novel columns and detectors into the existing OTIC portable instrument. The versatility of the instrument

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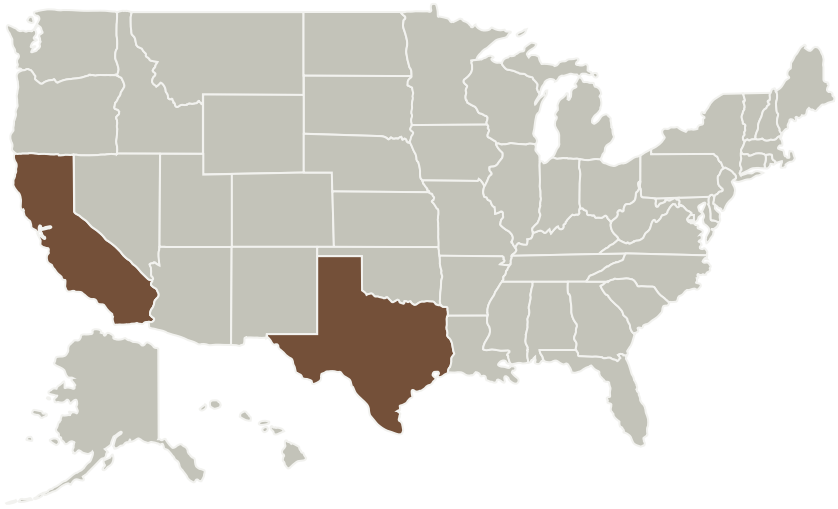
will make it well suited for other orbiter/lander missions, e.g., an Enceladus fly by orbiter for in-situ plume analysis.

Anticipated Benefits

Investigating the origin, possibilities, and potentials of life in extraterrestrial life as we know it is one of the basic objectives of many NASA missions. We are designing in-situ analysis platforms that can measure amino acids, building blocks of life as we know it, in exquisitely minute quantities and without further derivatization. There will be opportunities to test such instrumentation in future Mars Lander/Rover, Europa Lander and the Ocean Worlds flyby missions. The technology will also benefit amino acid analysis on this planet.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Texas at Arlington(UTA)	Lead Organization	Academia Hispanic Serving Institutions (HSI)	Arlington, Texas

Primary U.S. Work Locations	
California	Texas

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

The University of Texas at Arlington (UTA)

Responsible Program:

Planetary Instrument Concepts for the Advancement of Solar System Observations

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Haris Riris

Principal Investigator:

Purnendu K Dasgupta

Co-Investigators:

Christopher P Mckay
Aaron C Noell
Jeremy A Forsberg
Alfonso F Davila

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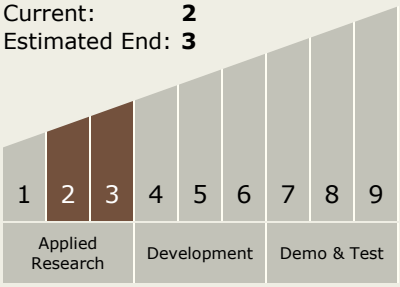
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.1 Field and Particle Detectors

Target Destination

Others Inside the Solar System